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The Hackberry Stage of the Upper Devonian.

BY CARROLL LANE FENTON.

I.—INTRODUCTORY.

At what is commonly known as the Hackberry Grove Clay Bank, in section 35, Portland Township, Cerro Gordo County, Iowa, is the type locality of the formation described in this paper. On the right bank of Lime Creek at that point is an escarpment some seventy-five feet in height which is composed throughout its exposed thickness of the rocks of two formations: the Hackberry and the Sheffield.¹ These two formations comprise the "Lime Creek Stage" as defined by Calvin,² but it is recognized, and was recognized prior to Calvin's description, that the two formations are distinct.

The nomenclature of these two formations had been considerably involved, as has also been the assignment of geologic age. Hall, in 1858³ assigned the beds of the Hackberry to the Hamilton Stage, but in a later paper by Hall and Whitfield⁴ they were considered as being Chemung. White⁵ referred the Hackberry shales to the Hamilton, and H. S. Williams attempted at one time to show that they were of Mississippian age,⁶ but later⁷ corrected this. C. L. Webster, in 1889,⁸ referred the Hackberry to the upper Devonian, but placed the subjacent shales in the Hamilton, but has corrected

¹ Am. Jour. Sci. (4), XLVIII, pp. 355-376.

² Ia. Geol. Surv. VII, pp. 161-192.

³ Geol. of Iowa; Vol. I; pts. 1 and 2.

⁴ Twenty-third Ann. Rep't, N. Y. State Cabinet, pp. 225-226.

⁵ Rep't of Geol. Surv. of State of Iowa, Vol. 1, pp. 187-188; Vol. 2, pp. 252-253.

⁶ Am. Jour. Sci. (3), XXV, pp. 97-104.

⁷ Loc. Cit., p. 311.

⁸ Am. Nat. XXIII, pp. 229-243.

the latter error in later papers. By the Iowa Survey the "Lime Creek" has been consistently and correctly assigned to the upper Devonian. In a recent paper by myself,¹ Webster and I referred the shales below the Hackberry to a possible Genesee time equivalency; in 1919² I applied the name Sheffield to these shales, but expressed no opinion as to their age except that they are of the late upper Devonian.

Webster, in 1889,³ in a paper on the Devonian of Iowa, divided it into three stages, the Corniferous, the Hamilton, and the Hackberry. His Hackberry Group was stated by him to consist of one formation which "is known to attain a thickness of forty-five feet, and is made up, for the greater part, of a yellowish brown argillaceous, and sometimes arenaceous shaley limestone." This formation was stated to be the highest Devonian in the state, and, while the description leaves much to be desired, there is no doubt that Webster's Hackberry Group, as originally described by him, includes all of the Devonian rocks above the blue shale at Hackberry Grove, Rockford, and other localities, and below the Kinderhook.

Prior to 1889 the names "Rockford Shales," "Lime Creek Shales," and "Lime Creek Beds" had been used by various authors. Calvin and Williams used all three interchangeably; Webster used the term "Rockford Shales." This name, however, was preoccupied by another formation, so had to be abandoned.

In 1897³ Calvin, in his report on the geology of Cerro Gordo County described the shales and limestones above what was then considered to be the Cedar Valley Limestone⁴ as the Lime Creek Stage, and this name has been used in the Iowa reports, and is more widely known than the name proposed by Webster. In 1919,⁵ I discussed the nomenclature of the two formations in question, attempting to show that: (1) The name "Lime Creek" as used by the Iowa Survey does not equal "Hackberry" as used by Webster and myself; (2) that a new formation name was needed

¹ Am. Mid. Nat. V. p. 214.

² See Note 8. The division of the Devonian below the Hackberry into Hamilton and Corniferous was erroneous.

³ Ia. Geol. Surv. VII., pp. 161-170.

⁴ The Nora Limestone of Thomas (Science, N. S., XXXVII, p. 459 was not separated from the Cedar Valley limestones at that time.

⁵ Loc. cit. pp. 355-360.

for the shales below the Hackberry, and (3), that the name "Lime Creek" is not only unsuitable, but is preoccupied, and so should be dropped.

Iowa Geological Survey (Published Reports)	Clement L. Webster (Early Papers, 1889)	C. L. Fenton
Lime Creek Stage	Hackberry Group	Hackberry Stage
Owen Substage	Upper Horizon	Owen Substage
Hackberry Substage	Middle Horizon	Cerro Gordo Substage
		Spirifer Zone
	Lower Horizon	Striatula Zone
	Genesee??? Stage	Sheffield Formation

FIG. 1.—CORRELATION OF NOMENCLATURES.

II.—STRATIGRAPHY AND DISTRIBUTION.

There is no point at which a satisfactory section of the Hackberry Stage may be taken. The following section, a compilation giving the maximum thicknesses observed, is here introduced in order to facilitate reference in the following description.

II. A.—GENERAL SECTION OF THE HACKBERRY STAGE.¹

II.—Owen Substage.

C.—Acervularia Zone.

Calcareous, light gray limestones, containing *Pachyphyllum*, *Alveolites*, *Acervularia* (an undescribed species; typical of the zone) *Stromatoporella*, *Syringostrota*, and other species, corals and *Stromatoporoids* being the most abundant forms.....20

B.—Naticopsis Zone.

Magnesian shales and limestones, and argillaceous dolomitic limestones, usually dark buff or brownish in color. Gastropods the predominating fossils, *Westernia* and *Naticopsis* the predominating genera; *Naticopsis gigantea* H. & W. the most typical species.....30

A.—Idiostrota Zone.

Buff, gray-buff, or buff-brown limestones, heavily bedded. Crowded throughout by two species of *Stromatoporoids*(?) commonly referred to *Idiostrota*, as well as other *Stromatoporida*, and several species of gastropods.....4-6½

I.—Cerro Gordo Substage.

B.—Spirifer Zone.

Yellowish, very calcereous shales, shaley clays, and shaley limestones. Weathers partly to clay, partly to limestone chips. Abundantly fos.

¹ For comparison with Calvin's section in Ia. Geol. Sun. VII., p. 163.

siliferous.....	20
A.—Striatula Zone.	
Calcareous shales and shaley limestones, slightly to very gritty. Weathers partly to a rather gritty clay, partly to chips and nodules, strongly iron stained. Beds indurated at various localities, as at Mason City; at Rockford and Hackberry Grove, bearing large numbers of calcareous concretions in the lower portions. Fossiliferous, the fossils occurring largely as casts.....	25

Disconformity.

At Rockford the Striatula zone attains a total thickness of above sixteen feet, and is separated into three quite distinct divisions. The lowest of these, about two feet in thickness, does not depend so much upon its fauna as the distinctive feature of a large number of calcareous concretions, containing considerable amounts of pyrite, and occasional crystals of feldspar. Fossils are conspicuous by their general absence, even poorly preserved casts being uncommon.

The second division, (Whitneyi Faunule, Fig. 3), contains the typical Striatula fauna. The less common species of this faunule were described by Webster in a paper in the American Naturalist¹; the most common ones are: *Schizophoria striatula* (Schloth.), *A. reticularis* (Linn.), *A. hysirix* Hall, and *Spirifer whitneyi* Hall. The total thickness of the faunule is about ten feet.

The third division, (Gypidula faunule, Fig. 3), is, to a considerable extent, a transition between the Striatula and the Spirifer zones. The fauna has lost its typical Striatula aspect, but yet it is sufficiently distinct from that of the Spirifer zone to be placed with the lower division. Among the typical Spirifer zone species appearing in this faunule are those marked by an asterisk in the faunal list. The most interesting of these is a large, undescribed species of *Gypidula*, commonly called *G. comis* (Owen). This form is, in general, rare throughout the formation, but in limited areas of the Gypidula faunule considerable numbers of specimens, usually badly crushed, may be found. I collected a total of thirteen specimens, only two of them good, from an area that could be covered by an ordinary sheet of paper. In the area having a radius of approximately fifteen feet about this find I have collected but four specimens, all fragmentary.

The accompanying diagram will serve to show the division of the Striatula into faunules at the localities studied. The division,

¹Am. Nat. XXII., pp. 1013-1018.

of course, is by no means so hard and fast as might be inferred from the diagram. The figures refer to the approximate thicknesses in feet.

Hackberry Grove.		Mason City B. & T. Co.		N. W. States Cem. Co.		Rockford B. & T. Co.	
		4	Reticularis Faunule.				
8	Whitneyi Faunule(?)	18	Fucoid Faunule.	8	Gritty, soft beds; few fossils.	3	Gypidula Faunule.
		20				12	Whitneyi Faunule
2	Concretionary Bed			$\frac{1}{2}$	Fucoid Faunule	2	Concretionary Bed

FIG. 3.—FAUNULES OF THE STRIATULA ZONE.

THE CERRO GORDO SUBSTAGE.

II. B.—THE STRIATULA ZONE.

The lowest division of the Hackberry, that referred to by Webster in his earlier publications as the "Lower beds" and the "Lower Horizon," is the one to which Webster and I have applied the name Striatula zone.¹ The most extensive development of this zone is at the pits of the American Brick and Tile Company and the Mason City Brick and Tile Company (owned and operated by the latter) at Mason City, in Cerro Gordo County, where it attains a thickness of at least twenty-five feet. The lower eighteen to twenty feet are composed of more or less indurated, fairly heavy-bedded strata of coarse, gritty texture, strongly iron stained. These beds contain abundant fucoid remains, the most abundant being a small form one-fourth to one-half inch in diameter. It lies along the bedding planes in tangled, curling masses, and is very characteristic of the lowermost ledges. Further up in the zone a larger, branching form, with a diameter sometimes reaching two and one-half inches, predominates. Both are associated together, but there is a distinct predominance of the small species below, and the large one higher up in the zone. The zone is the Fucoid faunule of Fig. 3.

Above the indurated beds containing fucoids as the principal fossils are six to eight feet of gritty, soft shales and clay-shales

¹American Midland Naturalist, V., p. 214.

which oxidize to a light yellowish. There are but slight traces of induration, and the oxidization is much more complete than in the lower beds. Fossils are quite common as casts, *Schizophoria striatula* (Schloth.), *Atrypa reticularis* (Linn.), *A. hystrix* Hall, and *Spirifer Whitneyi* Hall being the principal species. This bed composes the Reticularis faunule of Fig. 3.

At the pits of the Western States Cement Company, some three-fourths of a mile to the northwest of the Mason City pits the shales below the Hackberry is being worked for the production of cement. They are overlain by seven to nine feet of the Striatula Zone, which is stripped from the smooth, plastic formation below. The Striatula section, while incomplete in the extreme, nevertheless shows a great difference from that at the Mason City pits. The entire thickness of the indurated strata is represented by less than six inches of hard, shaley limestone, bearing furoids. Above this are seven or eight feet of material very similar to that described above as constituting the Reticularis faunule, but with very few fossils, and those as very poor casts. Mr. A. P. Potts, of the Mason City Brick and Tile Company tells me that the heavy, indurated beds have virtually disappeared less than three-eighths of a mile north of the Mason City pits. This is an extreme example of the decided local variation that characterizes the upper Devonian of this particular district.

II. C.—THE SPIRIFER ZONE.

The most striking, and certainly the most interesting, paleontologically of the divisions of the Hackberry is the Spirifer Zone, which at Hackberry Grove attains a thickness of approximately twenty feet. An exact determination of the boundary between the Spirifer and Striatula zones is made difficult by the talus.

This zone, as developed at Hackberry Grove, is divided into at least three faunules, though their bounds have not been very carefully worked out. The table on the following page gives these faunules, with the distinguishing characters.

The Striatula Zone in the neighborhood of Rockford, and particularly at the brick pits, is composed of much the same yellow, calcareous shales, but with a much lesser tendency towards induration than is to be noted at Hackberry Grove. The development of faunules is more obscure than at Hackberry Grove, and I am inclined to think that there is less parallelism between the

3. Stromatoporella Faunule.	Corals and stromatoporoids at their greatest abundance; <i>Charactophyllum</i> , <i>Pachyphyllum</i> , <i>Stromatorpoella</i> , <i>Syringostrota</i> predominating genera. Brachiopods gastropods abundant; <i>Naticopsis</i> more abundant than in Faunule 2. Pelecypods seemingly at height; <i>Paracyclas</i> predominating species.
2. Hystrix Faunule.	Brachiopods at greatest abundance; <i>Atrypa</i> , <i>Schizophoria</i> , <i>Strophonella</i> , <i>Douvillina</i> , <i>Spirifer</i> the predominating genera.
1. Gigantea Faunule	<i>Naticopsis gigantea</i> and <i>Floydia</i> the dominant gastropods. Brachiopods abundant. Corals much less abundant than in upper two faunules.

FIG. 4.—FAUNULES OF THE SPIRIFER ZONE AT HACKBERRY GROVE.

two localities than I at first supposed.¹ It is certain that the horizon of dominant gastropod development at Rockford is above that of dominant brachiopod development. The upper portions of the zone are not present, so the development of the Stromatoporella faunule, if it was developed, cannot be determined.

Three miles west of Rockford, at a roadside exposure known locally as Bird Hill, the Spirifer consists of two distinct faunal divisions. The lower is made up of compact clay-shales crowded with small fucoids, but without many other fossils; the second is of soft clay-shale similar to that of the Rockford pits, but with a distinctly different fauna. *Laoclema occidens* (H. & W.), common at the Rockford pits, is here almost uncommon, but the smaller bryozoa are to be found in abundance. Rugose corals (*Charactophyllum nanum* (H. & W.), *Zaphrentis solida* H. & W., *Chonophyllum ellipticum* (H. & W.)) are abundant, and on the whole are of a larger size than at Rockford. The general aspect of the brachiopod fauna is different from that at Rockford, though the species are much the same. There is a notable tendency among the *Spirifers* of the *hungerfordi* and *whitneyi* groups to develop wide forms, as *S. whitneyi producius* Fenton.

I think it has been made plain in these descriptions that there are distinct faunal differences in the Spirifer Zone. These faunal differences seem to me to be dependent on locality and local environment rather than upon time. Doubtless stratigraphical position and individual variations are related, but I am inclined to lay the major part of the responsibility to local environment.

¹ Am. Jour. Sci. XLVIII, p. 363.

The difference of the fauna at one point from that at another is far more easily seen in the results of a collecting trip than in a collection or in faunal lists, for the difference is primarily one of numbers of specimens, secondly of variations, and probably last, of species. This last statement cannot, of course, apply to such forms as *Lioclema occidens*, which, while abundant about Rockford is uncommon (relatively, at least) at Bird Hill, and rare at Hackberry.

THE OWEN SUBSTAGE.

II. D.—THE IDIOSTROMA ZONE.

The highest portion of the Hackberry Stage which is in place at Hackberry Grove is composed of four to six and one-half feet of rather heavily bedded limestone, gray, gray-buff, or buff in color, and crowded throughout by two species of Stomatoporeoids commonly referred to the genus *Idiostroma*. Associated with the species are several species of *Stomatoporella*, and numerous large specimens of *Naticopsis gigantea* H. & W. At a small exposure south and east of Hackberry Grove the lower portions of this zone contain numerous corals, among them being *Aulopora annectens* Clarke. *Westernia crassa* Webster, and *W. gigantea* Webster have been taken from this zone at Hackberry Grove. The limestones of the *Idiostroma* zone are very distinct, both lithologically and faunally from the underlying Spirifer beds. At all points where they were examined they were characterized by the two slender *Idiostromas*.

II. E.—THE NATICOPSIS ZONE.

The type locality for the Hackberry Stage is the Hackberry Grove exposure, and this same exposure furnishes the typical development of the Cerro Gordo Stage. The type locality for the Owen substage, and its upper two zones is the Owen Grove quarry, near Owen Creek, in Portland Township. At that locality there are some thirty feet of dark buff or brownish limestone, shales, shaley limestones, and dolomites overlying the *Idiostroma* beds, and characterized by their abundant gastropod fauna, in which the species *Naticopsis gigantea* predominates. The three species of *Westernia*, two or three unidentified species of *Ceneostoma*, and *Floydia concentrica* Webster, are among the other gastropods.

II. F.—THE ACERVULARIA ZONE.

Above the Naticopsis Zone at Owen Grove there is a slope of about twenty feet, on the surface of which are numerous fragments of limestone bearing, among other fossils, a new species of *Acervularia* that has been variously referred to *Acervularia profunda* Hall, and *A. inequalis* H. & W. by various authors. *Pachyphyllum woodmani* (White) is common, in at least three varietal forms; *Strombodes*, *Alveolites*, *Chonophyllum*, and other corals are present. There are several species of gastropods, and pelecypods of the genus *Paracyclas*; brachiopods are relatively uncommon.

In the bed of Hackberry Creek, east of the Hackberry Grove escarpment, there are large amounts of residual material from the Acervularia Zone, and it is here that the best collecting is to be found. Corals are common; stromatoporoids common, but less so than they would be in weathered Spirifer Zone material from Hackberry Grove. *Stromatoporella incrustans* (H. & W.), *S. solidula* (H. & W.) and several apparently undescribed species are among them. Both corals and Stromatoporoids are frequently pierced by what seem to be borings of a large species of *Cliona*, in no way allied to the *C. Hackberryensis* of the Spirifer zone.

II. G.—DISTRIBUTION OF THE FORMATION.

The accompanying map, made up by C. L. Webster and myself, will serve to show the general distribution of the formation. I am particularly indebted to Mr. Webster for data regarding the Owen Substage and the questionable Hackberry areas in Worth County. His long study of the formation has enabled him to secure much data that I could not, in my brief work, secure.

III.—THE FAUNA OF THE HACKBERRY.

The following list, while far from complete, will serve to give an idea of the fauna in general, and in its stratigraphic relationships. No attempt is made to enumerate all of the undescribed species; those noted are in all cases the most striking or most characteristic ones.

In the foregoing pages considerable mention of various species has been made, and the stratigraphic relations of many forms have been noted. In order, however, to give a satisfactory idea of the bases for division of the formation into substages and zones here described, the following list is divided into three sections: the

fossils of the Owen substage, those of the *Spirifer* zone, and those of the *Striatula* zone. Even this division, however, fails to give the true distinction between the last two subdivisions; this is apparent only in survey of the results of several days of careful collecting. It is a difference not so much of species as of numbers of species, and numbers of individuals, there being a greater abundance of both in the *Spirifer* zone.

In the following list, the abbreviation "sp." is used where the species is undetermined; the abbreviation "n. sp." indicates that the species (or variety: "n. var.") is undescribed.

FOSSIL SPECIES OF THE OWEN SUBSTAGE.

PLANTAE

"Fucoids," of at least two species, undetermined.

ANIMALES.

Porifera

Cliona sp. or sps. Large boring forms in *Alveolites*, *Acervularia*, *Pachyphyllum*, etc.

Coelenterata

Anthozoa

Heliophyllum sp.

Heliophyllum n. sp.

Chonophyllum ellipticum H. & W.

Chonophyllum sp.

Zaphrentis solida H & W.

Cystiphyllum mundulum H. & W.

Charactophyllum nanum (H. & W.)

Strombodes johanni (H. & W.)

Strombodes johanni multiradiatus (H. & W.)

Acervularia cf. *inequalis* H. & W.

Acervularia n. sp.

Acervularia n. sp.

Pachyphyllum woodmani (White)

Pachyphyllum woodmani (White) var.

Pachyphyllum crassisostatum Webster

Pachyphyllum crassum Webster

Alveolites rockfordensis H. & W.

Cladopora robusta Rom.?

Aulopora iowensis H. & W.

Aulopora cf. *saxivadum* H. & W

Aulopora annectens Clarke

Aulopora sp.

Aulopora n. sp.

Syringopora sp.

Hydrozoa (?) (Stromatoporoidea)

Stromatoporella sps.

Stromatoporella solidula (H. & W.)

Stromatoporella incrustans (H. & W.)

Stromatoporella n. s.

Syringostroma planulatum (H. & W.)

Idiostroma n. sp.

Idiostroma n. sp.

Vermes

Spirorbis omphaloides (Goldfuss)

Forms probably belonging to the Tubulifera.

Echinodermata

Various unidentified remains, fragmental, of crinoids.

Molluscoidea

Bryozoa

Hederella alternata (H. & W.)

Hederella sp.

Lioclema? sp.

Brachiopoda

Schizophoria striatula (Schloth.)

Leptostrophia canace (H. & W.)

Strophonella reversa Hall

Productella hallana Walcott.

Atrypa reticularis (Linn.)

Atrypa hystrix Hall

Atrypa hystrix planostulcata Webster

Spirifer orestes H. & W.

Spirifer hungerfordi Hall

Spirifer whitneyi Hall

Mollusca

Pelecypoda

Paracyclas validalinea Webster

Paracyclas sabini White

Paracyclas elliptica Hall

Leptodesma sp.

Gastropoda

Bellerophon sp.
Straparollus cf. cyclostamus Hall
Ceneostoma sps.
Pleurotomaria sp.
Diaphorostoma lineatum (Con.)
Floydia concentrica Webster
Naticopsis gigantea H. & W.
Westernia crassa Webster
Westernia owensis Webster
Westernia gigantea Webster

FOSSILS OF THE SPIRIFER ZONE.

PLANTAE

"Fucoids," three or more species.

ANIMALES

Porifera

Cliona hackberryensis Thomas
Cliona sp.

Coelenterata

Anthozoa

Zaphrentis solida H. & W.
Cyathophyllum n. sp.
Charactophyllum nanum (H. & W.)
Heliophyllum cf. scrutarium Clarke & Swartz.
Chonophyllum ellipticum H. & W.
Chonophyllum n. sp.
Strombodes johanni (H. & W.)
Strombodes johanni multiradiatus (H. & W.)
Pachyphyllum woodmani (White)
Pachyphyllum woodmani cf. gregarium Webster
Pachyphyllum crassicoatum Webster
Pachyphyllum ordinatum Webster
Pachyphyllum crassum Webster
Pachyphyllum n. sp.
Macgeea solitaria (H. & W.)
Macgeea parva Webster
Macgeea culmula Webster
Acervularia inequalis H. & W.
Acervularia n. sp.
Acervularia profunda Hall

Alveolites rockfordensis H. & W.

Cladopora cf. *robusta* Rom.

Cladopora cf. *palmata* H. & W.

Aulopora iowensis N. & W.

Aulopora saxivadum H. & W.

Aulopora filiformis Billings

Aulopora n. sps.

Syringopora sp.

Hydrozoa (?)

Stromatoporella solidula (H. & W.)

Stromatoporella incrustans (H. & W.)

Actinostroma cf. *expansum* (H. & W.)

Actinostroma n. sp.

Syringistroma planulatum (H. & W.)

Vermes

Serpularia, sps.

Cornulites, sps.

Spirorbis omphaloides (Goldfuss)

Spirorbis arkonensis Nich.

Echinodermata

Crinoidea

Unidentified Crinoid remains; about ten species (Webster).

Echinoidea

Nortonechinus n. s.

Spines of unidentified forms.

Molluscoidea

Bryozoa:

Vinella? sp.

Hederella alternata (H. & W.)

Hederella cf. *filiformis* Nich.

Lioclema occidens (H. & W.)

Lioclema minutissimum Nich.

Fenestella vera Uhlich

Fenestella sp.

Fridotrypa sps.

Brachiopoda

Crania famelica H. & W.

Crania famelica H. & W. var.

Crania crenistriata Hall

Schizophoria striatula (Schloth.)

Schizophoria striatula impressa (Hall)
Leptostrophia canace (H. & W.)
Leptostrophia perplana nervosa (Hall)
Stropheodonta n. sp. (cf. *calvini* Miller)
Stropheodonta exilis Calvin(?)
Douvillina, n. sp.
Douvillina arcuata (Hall)
Douvillina arcuata maxima Fenton
Strophonella reversa Hall
Strophonella reversa gravis Fenton
Strophonella reversa hybrida (H. & W.)
Schuchertella prava Hall
Schuchertella prava Hall
Schuchertella sp.
Productella hallana Walcott
Productella truncata Hall
Productella speciosa Hall
Gypidula comis munda (Calvin)
Gypidula cf. *comis* Owen
Rhynchonella subacuminata Webster
Camarotoechia contracta saxatilis Hall
Rhipidomella cf. *penelope* Hall
Pugnoides altus (Calvin)
Pugnoides ambiguus (Calvin)
Liorhynchus iris Hall
Liorhynchus sp.
Centronella navicella (Hall)
Cranaena calvini (H. & W.)
Atrypa reticularis (Linn.)
Atrypa reticularis hackberryensis (Webster)
Atrypa reticularis alta Fenton
Atrypa reticularis (Linn.) n. var.
Atrypa hystrix Hall
Atrypa cf. *spinosa* Hall
Atrypa cf. *aspera* Hall
Spirifer whitneyi Hall
Spirifer whitneyi rockfordensis Fenton
Spirifer whitneyi gradatus Fenton
Spirifer whitneyi productus Fenton
Spirifer — sp.

Spirifer hungerfordi Hall
Spirifer n. sp.
Spirifer macbridei Calvin
Spirifer orestes H. & W.
Spirifer substrigosus Webster
Spirifer websteri Fenton
Spirifer cyrtinaformis H. & W.
Spirifer cyrtinaformis helenae Fenton
Cyrtina hamiltonensis recta Hall
Ambocoelia sp.
Reticularia n. sp.
Athyris cf. *minutissima* Webster

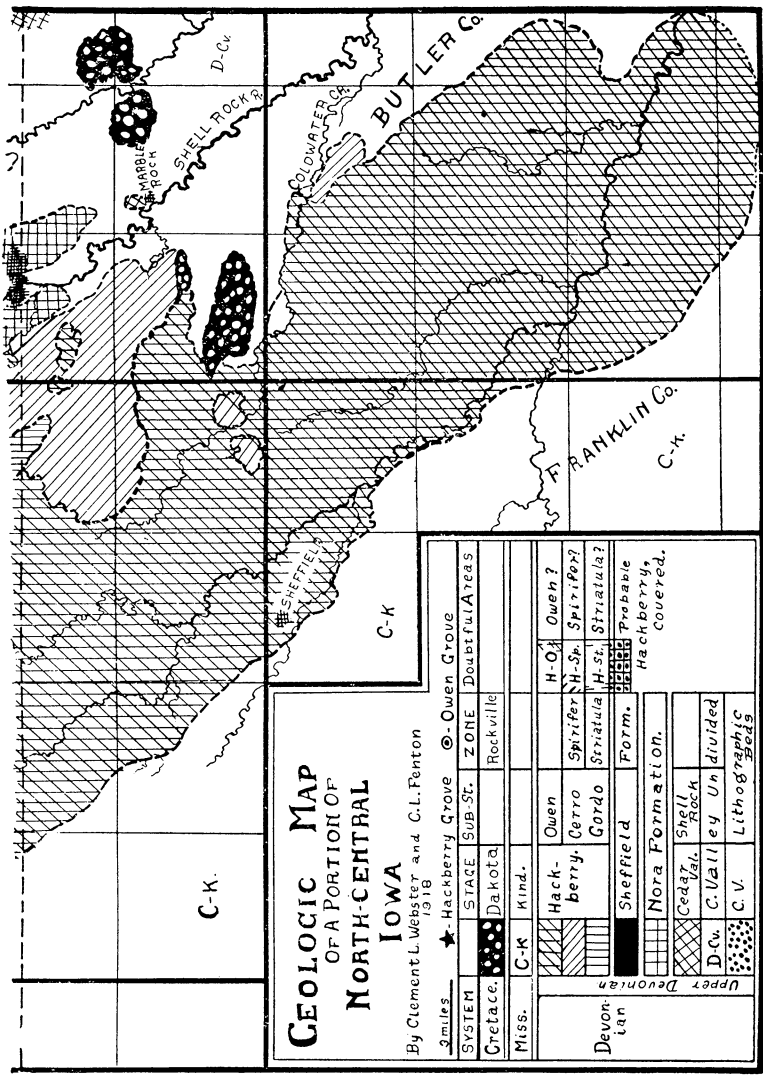
Mollusca

Pelecypoda

Grammysia sp.
Spenotus contractus Hall(?)
Leptodesma sp.
Lucina sp.(?)
Paracyclas sabini White
Paracyclas elliptica Hall
Paracyclas validalinea Webster
Glossites lingualis Hall
Pterinopecten sps.
Aviculopecten sps.

Gastropoda

Bellerophon sp.
Straparollus cyclostamus (Hall)
Straparollus sp.
Platyostoma(?) *insolitum* Webster
Platyostoma(?) *antiquum* Webster
Platyostoma(?) *modestum* Webster
Diaphorostoma cf. *ventricosum* (Con.)
Cyclonema sp.
Pleurotomaria verticillata Webster
Holopea(?) *iowensis* Webster
Holopea sps.
Naticopsis gigantea H. & W.
Naticopsis gigantea hackberryensis Webster
Naticopsis gigantea websteri Fenton
Naticopsis magnificentis Webster



of the Hackberry Stage, and other Formations.

Floydia concentrica Webster
 Floydia concentrica multisinuata Fenton
 Loxonema hamiltonensis Hall
 Loxonema sps.
 Platydesma sp.
 Paleotrochus sps.

Cephalopoda

Orthoceras berryx Hall
 Orthoceras consortale Hall
 Orthoceras sps.
 Gomphoceras sps.
 Manticoceras pattersoni (Hall)

Vertebrata

Piscea

Ptyctodus calceolus M. & W.
 Dinichthys pustulosus Eastman
 Diplodus striatus Eastman
 Diplodus priscus Eastman
 Apsidichthys sp.

FOSSIL SPECIES OF THE STRIATULA ZONE.

PLANTAE

"Fucoids," several species.

ANIMALES

Molluscoidea

Bryozoa

Lioclema occidens (H. & W.)*
 Undetermined species.

Brachiopoda

Crania famelica H. & W.*
 Leptostrophia canace (H. & W.)*
 Douvillina arcuata (Hall)*
 Gypidula cf. comis (owen) n. s.*
 Centronella navicella (Hall)*
 Centronella sp.
 Cranaena calvini (H. & W.)?*
 Schizophoria striatula (Schloth.)
 Atrypa reticularis (Linn.)
 Atrypa reticularis alta Fenton?*

* Found in the Gypidula faunule, at Rockford.

- Spirifer whitneyi Hall
- Spirifer hungerfordi Hall
- Athyris minutissima Webster
- Mollusca
 - Pelecypoda
 - Glossites sp.
 - Grammysia(?) sp.
 - Paracyclas sabini White*
 - Paracyclas validalinea Webster
 - Gastropoda
 - Platyostoma mirum Webster
 - Platyostoma pervetum Webster
 - Platyostoma sp.
 - Platyostoma n. sp.
 - Naticopsis rara Webster
 - Turbo (?) strigullata Webster
 - Turbo (?) incerta Webster
 - Holopea tenuicarinata Webster
 - Cyclonema brevilineata Webster
 - Cyclonema subcrenulata Webster

IV.—THE AGE AND RELATIONSHIPS OF THE HACKBERRY STAGE.

In section I of this paper there is given a summary of the age and equivalency of the Hackberry beds; it is not necessary to review this here. The two important questions are: (1) Is there any described equivalent of the Hackberry Stage? (2) What claims to the rank of stage can be advanced for the formation?

The first question can be answered with a decided negative. Calvin, interpreted the fauna of the Independence Formation of Iowa as the predecessor and direct ancestor of the Hackberry Fauna. This interpretation, however, was based on a very small number of species, and it is doubtful if some of these can be satisfactorily referred to both formations.

Clarke[†] saw a considerable relationship between the Hackberry, Independence, and High Point faunas. His conclusions, however, were drawn, as shown in the table given by him, from but a small fraction of the bryozoan, brachiopod and mulluscan faunas of the Hackberry, the total number of species from the three formations which were included in the table being forty-three. Aside from

[†]Bulletin 16, U. S. G. S.; pp. 74-76.

paleogeographic difficulties, the paleontologic evidence is against rather than in favor of correlation of the Hackberry with the High Point.

If an equivalent for the Hackberry is to be found, it must be looked for in the north and west rather than in the east. The similarity of certain Hackberry species with forms from northwest Canada and from western United States¹ is of interest. Thus certain western forms of *Spirifer whitneyi* Hall are strikingly like the Hackberry form which I have called *S. whitneyi gradaius*. But as yet nothing of sufficient importance to allow for correlation has come up. Therefore, if we except time equivalency, we may state without question that there is no described equivalent of the Hackberry Stage.

But is this formation a stage? Some writers think not; in one publication of the Iowa Survey the formation was referred to as a substage.² On the other hand, Calvin, Webster, Thomas, and others have not hesitated to give the Hackberry the rank of stage or group.

It is true that if we compare the thickness of the rocks of the Hackberry with that of such formations as the Cedar Valley—to take another Iowa Devonian formation—or with the great thicknesses of some of the eastern formations, it makes but a poor showing. But thickness of sediments does not make a stage, just as it does not make a system. Fossils provide the evidence which can be relied upon.

The great difference of the Hackberry fauna from that of any other described formation has been dwelt upon; that feature is of importance in this connection as well as in correlation. The radical change of the Hackberry fauna from those preceding it in the Iowa region is also of note. So far as known now, there is not a single fossil species in the Sheffield formation which is found in the Cedar Valley or Nora formations. So far as known, there is not a single species common to the Hackberry and Sheffield formations. The number of species common to the Hackberry and the Cedar Valley is small, and by careful study will become smaller.

On the other hand, if one is to consider the wealth of species, and the wealth of new species, in the Hackberry, the arguments for giving the formation the rank of stage are greatly strengthened. The number of formations in the Paleozoic which can show as

¹See particularly Kindle; Bulletin 391, U. S. G. S.

²Eastman, Ia. Geol. Surv. Vol. XVIII, pp. 45-50.

prolific and as distinct a fauna, with as many forms known from that formation alone, is by no means great. And when it is recollected that the maximum *composite* thickness of the formation is but one hundred feet, and the average thickness very much less, there seems even less reason to call the formation a substage. Moreover, if one calls a formation a substage he implies that it is a division of some stage. But since there is no known equivalent of the Hackberry, to what stage might it be referred?

V.—SUMMARY.

1.—The highest, and youngest, position in the Devonian of Iowa is occupied by a formation whose known maximum composite thickness is about one hundred feet.

2.—This formation has been discussed under various formation names. The name *Hackberry*, proposed in 1889, has priority over other names and is more directly suitable to the formation than any other name which has been applied to it. Other names should therefore be regarded as synonyms, and should not be applied to this formation.

3.—The Hackberry formation is distinct, with no described equivalent. It is correctly designated as a stage (or group, as that term is commonly used).

EXPLANATION OF PLATE

FIGS. 1—2. *Atrypa reticularis alta* Fenton. A characteristic *Spirifer* zone form, found both at Hackberry Grove and Rockford.

FIGS. 3—4. *Spirifer whitneyi rockfordensis* Fenton. An erratic form of considerable rarity, which I have found only at Rockford.

FIGS. 5—6. *Spirifer whitneyi productus* Fenton. A form of *S. whitneyi* seldom found at Hackberry, sparingly at Rockford, but characteristic of the Bird Hill exposure. Specimen from Rockford.

FIGS. 7—10. *Spirifer whitneyi gradatus* Fenton. Rockford, Ia. A form best developed in the Rockford district, in the middle portion of the *Spirifer* zone.

FIGS. 11—17. *Spirifer cyrtinaformis helenae* Fenton. Rockford, Iowa. Specimens showing the slanting area and produced hinge-line which is particularly characteristic of the Bird Hill specimens. Good examples are less common at Rockford, and still less so at Hackberry.

FIGS. 18—22. *Strophonella reversa gravis* Fenton. Rockford, Iowa. A form which, although usually best preserved at Rockford, is more characteristic of Hackberry Grove, Gigantea faunule.

FIGS. 23—25. *Douvillina arcuata maxima* Fenton. Hackberry Grove, Iowa. A form which is found mainly at Hackberry Grove.

- FIG. 27. *Spirifer websteri* Fenton. Rockford, Iowa. A distinct species of the *orestes* group. I originally referred to this form the one shown in Figs. 28-31, but this was incorrect.
- FIGS. 26; 28-31. *Spirifer* species undescribed. Rockford, Iowa. Another species of the group of *S. orestes* H. & W. *Spirifer* zone; about equally characteristic of Rockford and Hackberry Grove.

EXPLANATION OF PLATE

- FIG. 1—2a. *Naticopsis gigantea* Hall and Whitfield. Hackberry Grove, Ia.
- FIG. 3. *Naticopsis gigantea* Hall and Whitfield. A large specimen, upper whorls restored. Hackberry Grove, Iowa.
- FIG. 4. *Floydia concentrica multisinuata* Fenton. Holotype. Rockford, Iowa.
- FIG. 5.—5a. *Floydia concentrica* Webster. Fig. 5; portion of a large specimen. Fig. 5a; cross-section of shell of specimen shown in Fig. 5. Rockford; Iowa.
- Figures 1-3 are characteristic *Spirifer* zone forms from Hackberry Grove. Figures 4-5 show two typical specimens from the upper part of the *Spirifer* zone at Rockford.

A Consideration of Certain Genera Proposed by Ehrhart.

BY HOMER D. HOUSE

The question of what constitutes proper publication of a genus has received more than a little attention both in codes, proposed, promulgated or adopted, and by individual expression of opinion. A new genus published today without description but merely by the implication or indication of a type species would certainly seem inadequately published. However any code or set of rules which is retroactive is sure to encounter perplexing situations, which lead sooner or later to various evasions or deliberate exceptions.

This article deals with a set of generic names published by Friedrich Ehrhart in 1789 (*Beitrage zur Naturkunde und den damit verwandten Wissenschaften*, etc. 4: 146-148. 1789). Like many genera published by Rafinesque, Sweet, and several other early writers these genera were published without description, merely by the designation of a previously published species. The frequency with which this sort of generic publication occurs indicates that it must have been at the time regarded as a quite proper method. Many of Necker's genera are now regarded as



PLATE I.—FENTON ON THE HACKBERRY STAGE.

East portion of Hackberry Grove Clay Bank, the type exposure of the Hackberry stage. The escarpment here is about 76 feet high, the upper 36 feet being Hackberry shales. The lower 40 feet are of Sheffield age, mostly covered by Hackberry talus.

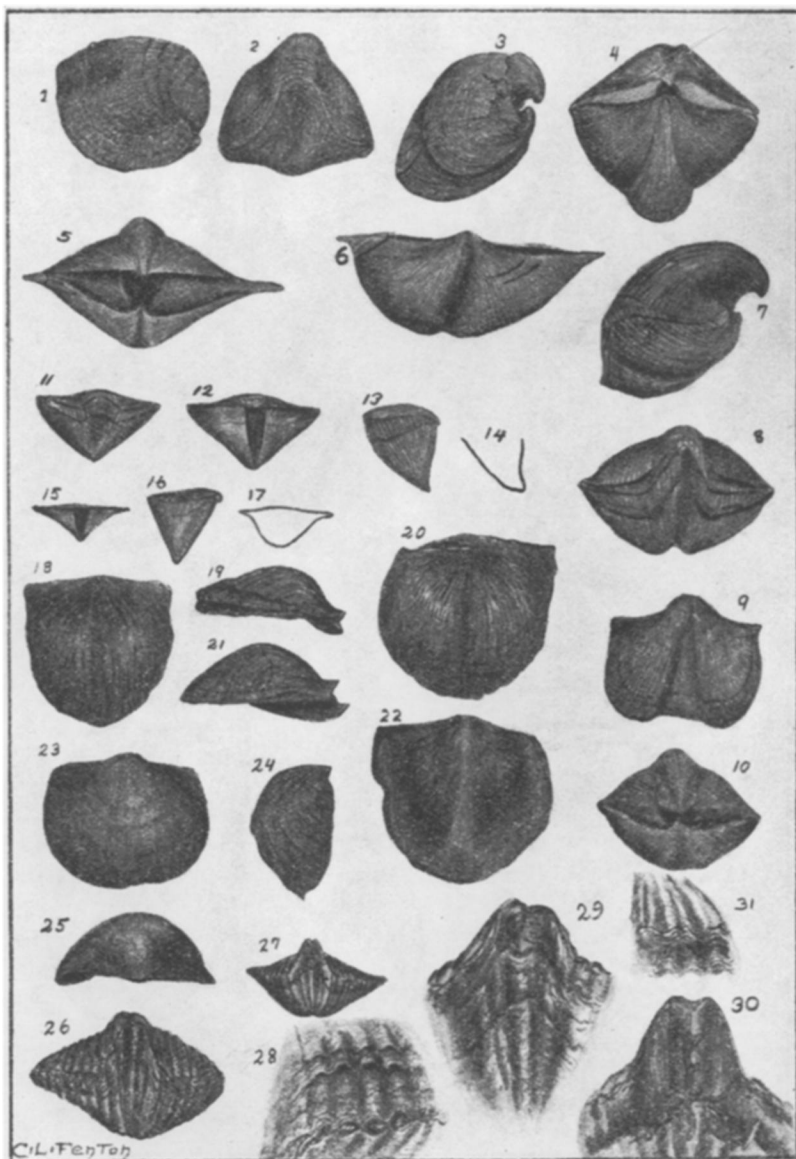


PLATE II.—FENTON ON THE HACKBERRY STAGE.

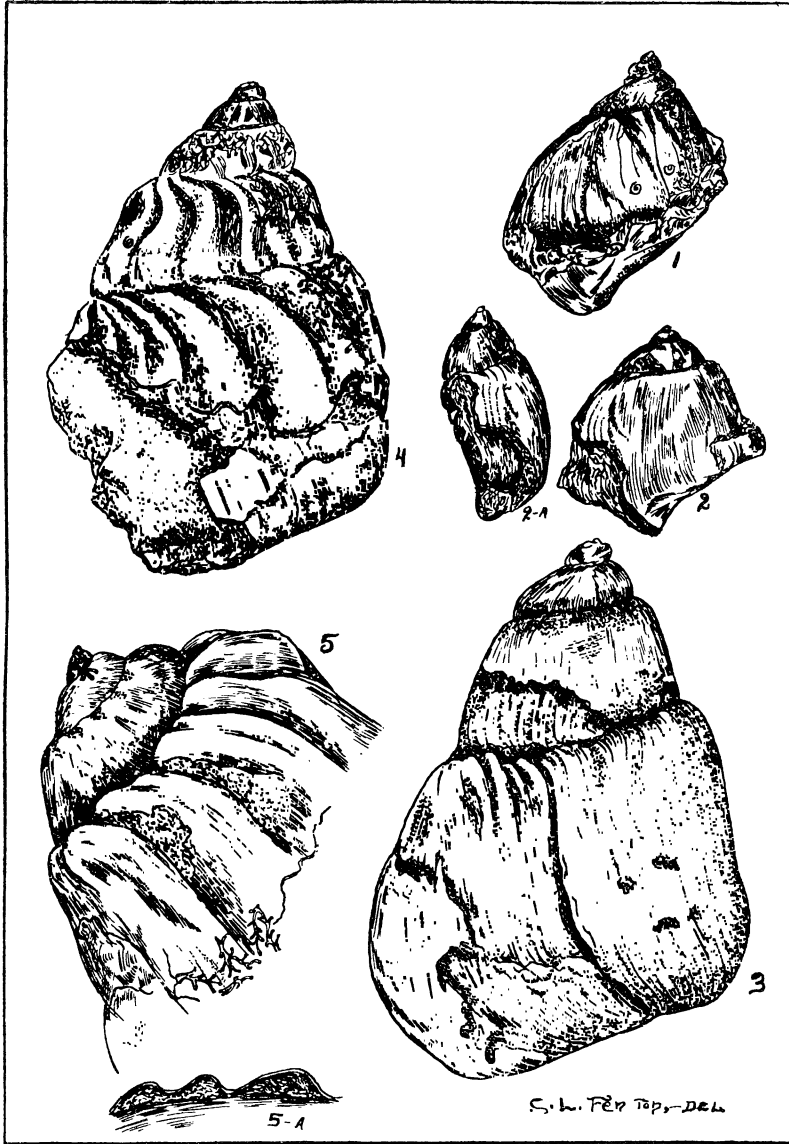


PLATE III.—FENTON ON THE HACKBERRY STAGE